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ON THE HEART*

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THE EFFECTS OF ATHLETIC SPORTS ON THE HEART.*

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The healthy heart is a very adaptable organ. Lewy has shown that the functional activity of the heart increases fourfold during moderate exertion and thirteenfold during severe exertion. But in addition to this functional adaptability the heart has a well marked trophic adaptability. This is shown normally after birth when the left ventricle hypertrophies to take entire care of the systemic circulation. It is shown in the gradual enlargement of the heart which takes place during middle age as the arteries become less pliable and offer more resistance to the blood stream. It is beautifully shown in cases of valvular lesions of the heart.

In the instances just cited the heart is enlarged to take care of a constant stress in excess of what it has before been called upon to meet. But the heart also enlarges to take care of an extra stress which occupies but a part of the twenty-four hours or occurs even less frequently than once a day. Thus it has been definitely shown that the hearts of manual laborers are, as a rule, larger (Schieffer, 1908) and heavier than those whose occupations demand little muscular effort. Külbs (1906) has shown experimentally that the hearts of dogs kept at work on a tread mill are far heavier and larger in proportion to the weight of the skeletal muscles than the hearts of dogs not thus kept at work. Schieffer (1908) has shown that in most instances the hearts of men undergoing military training in Germany enlarge during the year. In most of these cases the enlargement of the heart seems to be "physiological," the functional capacity of the heart is increased without noticeable detriment to its ordinary functions. In case of the soldiers, however, there are some whose hearts cannot stand up under the stress of the training, and it may be that in other instances the ultimate strength of the heart suffers. It is well known that heart trouble is very prevalent among the Tübingen peasants, Cornish miners, and others whose occupations are

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severe. The heart enlarges but does not become strong enough to meet the demands made upon it.

The severe strain which athletes put on the heart at intervals stimulates to a greater hypertrophy than is usually found among manual laborers. Thus Schieffer, 1908, found that among bicycle racers who had ridden for some years, the hearts were, on the average, considerably larger than the hearts of manual laborers. Barach, in a study of men training for a Marathon race, found that of the men whose hearts were not much above the average size, none were able to finish the race. Those who finished all had markedly hypertrophied hearts.

Recent study of the effects of muscular exertion has shown that during muscular exertion the pulse rate and blood pressure are both raised. The heart has not only to beat faster but against more resistance. The increased demands for blood, on the part of the body, are met in part by the greater frequency of the beat and, in part, by an increase in the amount of blood expelled at each systole. The latter adaptation, while it calls for more muscular energy, has the advantage of making a somewhat longer diastole possible and thus offers more opportunity for supply of blood to the heart muscle. Fatigue is thus somewhat postponed, but if extreme exertion is persisted in the cardiac muscle may be so weakened that it will stretch more during diastole than it can contract during systole. The heart thus becomes dilated. If the dilatation is extreme, the typical symptoms of acute dilatation may intervene. Recovery may sometimes apparently take place within a few hours or days. In other cases a permanent injury is clearly to be followed. In cases where the heart is frequently subjected to overstrain and where compensation is fairly good in spite of dilatation, the heart wall hypertrophies and we have a typical hypertrophied and dilated heart, frequently with signs of mitral insufficiency.

Today I desire to give a brief report of the work recently begun at the State University by Drs. Shumacker and Middleton on the study of the effects of athletics in high school and college on the heart. A full report of the first part of this work will shortly be published in the Journal of the American Medical Association. The results so far obtained are briefly summarized in the following tables:

In Group I, Table I, are summarized the find-

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ings in thirteen healthy young students who have taken no part in the severer athletic sports. The pulse rate at rest, sitting, averaged 80, and after fifty running steps 107, an average rate of increase of 34%. The systolic blood pressure at rest, sitting, averaged 117, the diastolic pressure 73, the pulse pressure 44.

In Groups 2-5 are summarized the findings in thirty-six men active in college athletics who gave no history of any condition other than athletic sports which could account for cardiac lesions. No

crease of 20, 24%. The hearts of these men were therefore less easily excited to rapid action than those of non-athletes. The systolic pressure was 122, slightly higher than the average obtained for non-athletes (not enough difference to mean much considering the number examined). The difference in diastolic pressure (90 as compared with 73) and pulse pressure (32 as compared with 44) is, however, probably significant. In all athletes examined the diastolic blood pressure was relatively high.

TABLE I.

Pulse rate and blood pressure in college athletes.

GROUPS	AVERAGE RESULTS					
	PULSE RATE			BLOOD PRESSURE		
	Before Test	After Test	Per Cent Increase	Diastolic	Systolic	Pulse Pressure
I Control (13 cases)	80	107	34	73	117	44
II Athletes with "normal" hearts (3 cases)	83	103	24	90	122	32
III Athletes with large hearts and slow pulse (10 cases)	61	81	32	94	126	32
IV Irritable hypertrophied hearts (11 cases)	77	115	50	99.8	135.3	35.5
V Hypertrophied hearts, Systolic murmurs before and after test (12 cases)	81	112	38	83	115	32
VI. Acute Dilatation a. One year before test	72	84	17	95	122	27
b. Three ^{Fifteen} months before test	100	135	33	99	121	22

attempt at selection was made other than to pick out men free from a medical history which might have affected the heart. As many of the more prominent college athletes as could be conveniently reached last spring were invited to submit to simple tests along the lines given above for non-athletes. About three-fourths of the more prominent college athletes responded. Only those are tabulated who had taken part in the severer sports in college: crew, football, basket-ball and track.

Of the thirty-six men examined three, 8.4%, had slightly hypertrophied but otherwise apparently normal hearts. The pulse rates before and after the test were, respectively, 83 and 103, a rate in-

In Group 3 we have summarized the results found in 10 athletes with greatly hypertrophied hearts, slow pulse rate (averaging 60.6 at rest), an increase in pulse rate in response to moderate exercise about like the normal heart (32%), a high diastolic pressure (94) and a low pulse pressure (32). As a rule the systolic pressure was not high although in one case it was 146. In two cases there were mitral murmurs after exercise. The individuals in this group represent the best athletes in college.

In Group 4 we have a summary of 11 cases of "irritable" hearts. The individuals in this group all had enlarged hearts, the rate of beat of which

jumped up 50% after moderate exercise. Both the systolic and diastolic pressure were relatively high, especially the latter. Such hearts evidently do not adjust themselves so readily to muscular exertion as do those in the former group. Some will, however, perhaps hypertrophy more and get at least a temporary greater stability. Others probably will pass over into the following group.

In Group 5 there are placed twelve athletes whose hypertrophied hearts gave distinct mitral murmurs before and after the test. The pulse rate increased after moderate exercise somewhat more than in the

college athlete is, as a rule, mainly developed in college. About five per cent. of the high school boys who come to Wisconsin have a cardiac hypertrophy attributable to athletic sports. But the star high school athlete, less frequently than is commonly supposed, develops into the star college athlete. In some instances the heart has been somewhat seriously injured in high school athletes so that it is not strong enough for the strain of college sports. In other cases there seems to be a lack of vigor.

In Group 1, Table II, are given data concerning

TABLE II.

Pulse rate and blood pressure in college athletes out of training for some years.

GROUPS	AVERAGE RESULTS					
	PULSE RATE			BLOOD PRESSURE		
	Before Test	After Test	Per Cent Increase	Diastolic	Systolic	Pulse Pressure
I High School Athletes (a.) Fast pulse. Murmur before test (2 cases)	80	138	73	91	145	54
(b.) Slow pulse. Murmur before and after test in one case (2 cases)	63	93	33	90	119	29
II Old College Athletes (a.) Irritable heart systolic thrill	78	110	41	77	116	39
(b.) Mitral murmur before test	88	?	?	78	104	26

normal individual. The systolic pressure was about normal, but the diastolic pressure was relatively high, although not so high as in the cases where the valves were intact. The athletes in this group are capable of going through severe contests, but probably not without some danger of inciting serious cardiac trouble.

In Group 6 are summarized the results found in two athletes who had suffered from acute cardiac dilatation, one a year before, the other three months before the test. In the former case the chief abnormality was the high diastolic pressure; in the latter case, in addition to a high diastolic pressure, there was a high pulse rate at rest, and a considerable jump in rate after moderate exercise.

The cardiac hypertrophy characteristic of the

four students who had overstrained the heart in high school athletics but had spent several years in college without taking part in severe competitive sports. In three cases there were mitral murmurs before or after a test of fifty running steps. In two cases there was a high pulse rate with a marked increase after exercise, and a high blood pressure. In two cases the pulse was relatively slow, the increase in rate after exercise was about normal and the diastolic pressure was high.

In Group 2, Table II, are given data referring to two students who had been college athletes several years before the test. In one the chief abnormal features were a systolic thrill and a marked increase in pulse rate after fifty running steps. In the other there was a mitral murmur before the

*directly or indirectly
to athletics.*

test and there were a relatively low systolic pressure and pulse pressure but otherwise normal conditions.

From the data presented it is clear, I think, that severe athletic contests cause marked cardiac hypertrophy in individuals who are strong enough to take part in them. The cardiac hypertrophy gives greater capacity to stand prolonged severe muscular exertion, but is usually associated with some signs of functional disturbance. About the ultimate result in the life of the individual of an athletic heart acquired in youth we know little. For ordinary vocations and avocations an over-large heart can be of little use. Unless it is kept exercised it will assuredly undergo a detrimental retrograde metamorphosis. Furthermore, most pathologists believe that the musculature of an hypertrophied heart is always somewhat diseased and less resistant than that of the normal heart. The degree of myocarditis varies in different individuals.

The hypertrophied heart is more liable to acute cardiac dilatation than the normal heart. At the state university, during the past two years, there have been ~~four~~ *three* cases of acute dilatation in athletes and only one in the non-athletes, although relatively few students take part in the major college sports. In case of severe fever these large hearts

seem to be especially vulnerable. In the graduates from Annapolis it has been found that there are six times as many deaths from ~~heart disease~~ among athletes as among non-athletes. If physical training is to be made compulsory in our schools and violent athletic contests are to be incited by crowds and publicity, a serious duty devolves upon the medical profession to study the results carefully and, in case of each individual youth, to supply that balanced judgment concerning the value of various kinds of physical exercise which only those can have who follow human life from the womb to the winding sheet. The physical trainer has his hands full in endeavoring to teach grace and skill in bodily movements. We should no more expect him to be deeply skilled in medical science and medical judgment than we can expect the expert physician to be an expert in teaching skill in the use of the muscles. The medical profession must insist that the public does not confound physical training, an excellent thing in itself, with personal, preventive medicine, which is quite a different thing. At the state university this is recognized. The department of clinical medicine has charge of the medical supervision of student health. It is distinct from the department of physical training with which, however, it endeavors to co-operate in promoting the welfare of the students.

